UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

SINGULAR COMPUTING LLC,

Plaintiff,

v.

GOOGLE LLC,

Defendant.

Civil Action No. 1:19-cv-12551 FDS

Hon. F. Dennis Saylor IV

DEFENDANT GOOGLE LLC'S PRELIMINARY CLAIM CONSTRUCTION BRIEF

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I. INTRODUCTION

The asserted patents, which have similar claims and share a substantially identical specification, claim a processor or other device for performing “low-precision, high-dynamic range” (“LPHDR”) arithmetic. These claimed “LPHDR execution units” are designed to perform “approximate computing,” yielding results that “frequently differ from exact results.”

The way in which the asserted patents claim a minimum error rate, however, renders them indefinite. Specifically, the patents claim that the LPHDR execution units produce results that, on average and over “repeated execution,” exhibit some minimum amount of difference between the LPHDR unit’s calculation and the “exact mathematical calculation.” Thus, the claims require, for example, that the “statistical mean [i.e. average] over repeated execution” of the LPHDR unit’s output, “differs by at least Y=0.05%” from the output of an exact mathematical calculation on the same input(s). As a matter of basic mathematics, the number of executions of an operation will affect the “statistical mean” of results that must be compared to an exact result—if each execution of an operation leads to a different result, the average of all results can shift with each execution. Accordingly, understanding how many repetitions are necessary to constitute “repeated execution” is necessary to determining whether this claim requirement is met. But neither the claims nor the specification provides any guidance regarding how many repetitions constitute “repeated.” Moreover, a person of ordinary skill in the art would not understand how many executions are enough to be “repeated” in the context of the asserted patents. Consequently, the asserted claims, which all include this requirement, are indefinite.

Separate and apart from this indefiniteness argument, Google proposes constructions for two terms: (1) “low precision high dynamic range execution unit,” and (2) “first input signal

representing a first numerical value."[1] As to the first term, Google's proposal is faithful to the description in the common specification, in contrast to Singular's proposal, which construes only the term "execution unit" and does so in a way that is inconsistent with the other claims and the specification. As to the latter term, Google's proposal again adheres to the intrinsic evidence, and it provides necessary clarity as between the claimed "signal" and the claimed "value." While Singular does not propose construing this term at all, Google's construction helps avoid another potential indefiniteness issue and will aid a jury in applying the subsequent claim element. Based on the Federal Circuit's well-worn claim construction precedents, Google respectfully requests that the Court adopt Google's proposed constructions if the Court finds the claims not indefinite.

II. BACKGROUND

The asserted patents[2] embody a principle familiar to anyone who has ever played a game of horseshoes: it isn't necessary to hit the target exactly; getting close is often good enough. To that end, the asserted patents claim a processor (or other device) designed to perform "approximate computing"—one that "does what computer engineers call 'sloppy arithmetic,' or 'guesstimating.'" Decl. of Andrew Bruns in Support of Google's Preliminary Claim Construction Brief ("Bruns Decl."), Ex. 1 (Peter Burrows, "Innovator: Joseph Bates"). For example, the asserted patents' claims encompass a processor "hardwired to be incapable of performing mathematical calculations correctly." *Id.*[3]

[1] Because every asserted claim includes the term "repeated execution," the parties' other proposed constructions are moot if the Court finds "repeated execution" indefinite.

[2] The asserted patents are U.S. Patent Nos. 8,407,273; 9,218,156; and 10,416,961. *See* Dkt. No. 37 (First Amended Complaint), ¶ 27. Because all three patents share a common specification and do not contain materially different claim language, this brief cites the '273 patent.

[3] These articles describe Dr. Bates' development of Singular's S1 chip, which Singular has identified as embodying the invention described in the asserted patents. Bruns Decl., Ex. 2 (Singular response to Interrogatory No. 3).

Notwithstanding this emphasis on performing "approximate" computations, the processor described in the asserted patents shares much in common with traditional computer processors. Like any other processor, for example, the claimed invention incorporates one or more processing elements—that is, "execution units"—that perform computations and a control unit that determines what computations the elements perform. *Compare* '273 patent at 3:49-56 (describing how a typical, prior art array processor "distribute[s] data across a grid of processing elements" and receives "[i]nstructions . . . from a central control [unit]") *with* '156 patent at 29:54-30:6 (claiming a device containing at least one "execution unit" and a "first computing device adapted to control the operation of the . . . execution unit"). Indeed, neither the concept of "approximate computing" nor the general architecture of the claimed device is novel. Dr. Joseph Bates—Singular's founder and the named inventor on the asserted patents—has "freely admitted" that "[i]mperfect computing . . . is not an idea that's unique to . . . Singular Computing," Bruns Decl., Ex. 3 (Berkeley Design Technology, Inc., "Imperfect Professing: A Functionally Feasible (and Fiscally Attractive) Option, Says Singular Computing"); *see also* '273 patent at 4:9-12 (describing a prior art processor that "provide[s] low precision arithmetic, in which each operation might introduce perhaps an error of a few percentage points in its results"). In fact, Dr. Bates "stresse[d] that" almost everything about the claimed invention can be found "in a 1994 textbook." Bruns Decl., Ex. 3 (Berkeley Design Technology, Inc., "Imperfect Professing: A Functionally Feasible (and Fiscally Attractive) Option, Says Singular Computing").

What Dr. Bates told the media distinguishes his purported invention from traditional computer processors and other "approximate computing" devices is how the invention implements the approximate computing concept within specially designed processing elements. *See id*. But the processing elements are also, like the processor itself, largely like other computing processing

elements. The processing elements in the claimed invention—the LPHDR execution units—perform computations. '273 patent at 5:65-6:2. The inputs to these computations generally take the form of "electrical signals representing numerical values." *Id.* at 10:67, 12:54-55. Those electrical signals can be *analog* (*e.g.*, electrical "charges, currents, voltages, frequencies, pulse widths, pulse densities, various forms of spikes," *id*. at 14:19-20), *digital* (*e.g*., binary electrical signals, *id.* at 11:53-54), or some combination thereof (*e.g.,* 14:53-54 and 24:54-57).

The LPHDR execution units aren't designed to always produce mathematically exact results from these computations. According to the inventor Dr. Bates, if you asked one of these LPHDR execution units "to add 1 and 1 . . . you will get answers like 2.01 or 1.98." Bruns Decl., Ex. 4 (Tom Simonite, "Why a Chip That's Bad at Math Can Help Computers Tackle Harder Problems"). Neither the specifications nor the claims in the asserted patents describe or claim what about the LPHDR execution units causes their results to be different from exact calculations. But prior art literature on approximate computing discloses certain circumstances that could lead to such a difference. Thus, for example, the LPHDR execution units could generate approximate results by skipping certain discrete steps when performing particular calculations. Bruns Decl., Ex. 1 (Peter Burrows, "Innovator: Joseph Bates"). Alternatively, in lieu of performing new calculations, the LPHDR execution units could simply apply the results from a previously performed calculation to similar calculations using similar inputs (a process called "memoization"). *Id.*, Ex. 5 (Sparsh Mittal, "A Survey of Techniques for Approximate Computing"); *id.,* Ex. 6 (Gennaro Rodrigues, *et al*., "Survey on Approximate Computing and its Intrinsic Fault Tolerance"). And, as just one more example, the LPHDR execution units could also reduce the precision of the numerical values on which they are operating. *Id.*, Ex. 5 (Sparsh Mittal,

"A Survey of Techniques for Approximate Computing"); *id.,* Ex. 6 (Gennaro Rodrigues, *et al*., "Survey on Approximate Computing and its Intrinsic Fault Tolerance").

Regardless of the particular method of approximation, the asserted patents specify that the LPHDR execution units must produce results that, on average, differ from exact calculations by some minimum degree. Specifically, the LPHDR execution units must generate, for a certain minimum percentage (X%) of the possible numerical inputs to a particular computation, an average result that differs by a minimum percentage (Y%) from the mathematically correct result of the computation. '273 patent at 29:65-30:16. The claims in the asserted patents specify that the degree of difference be ascertained by calculating the "statistical mean" of the values that result from "repeated execution" of the operation on each specific input value and comparing that statistical mean to the "result of an exact mathematical operation" on the same inputs. *Id.* at 30:8-15.

III. ARGUMENT

A. The claim term "repeated execution" is indefinite because it fails to delineate the metes and bounds of the asserted patents' claims.

"repeated execution"	
Claims	**Google's Proposed Construction**
All claims	Indefinite

1. Legal standard

A patent is invalid for indefiniteness under 35 U.S.C. § 112 if "its claims, read in light of the patent's specification and prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention." *Nautilus, Inc. v. Biosig Instruments, Inc*., 134 S. Ct. 2120, 2123 (2014). The purpose of this "definiteness requirement" is "to ensure that the claims delineate the scope of the invention using language that adequately notifies the public of

the patentee's right to exclude." *Datamize, LLC v. Plumtree Software, Inc*., 417 F.3d 1342, 1347 (Fed. Cir. 2005). "Otherwise, competitors cannot avoid infringement, defeating the public notice function of patent claims." *Halliburton Energy Servs., Inc. v. M-I LLC,* 514 F.3d 1244, 1249 (Fed. Cir. 2008). As the Supreme Court held over 80 years ago:

> To sustain claims so indefinite as not to give the notice required by the statute would be in direct contravention of the public interest which Congress therein recognized and sought to protect. . . . A zone of uncertainty which enterprise and experimentation may enter only at the risk of infringement claims would discourage invention only a little less than unequivocal foreclosure of the field.

United Carbon Co. v. Binney & Smith Co., 317 U.S. 228, 233, 236 (1942).

Under well-settled law, the metes and bounds of a claim are not reasonably clear when different potential testing leads to different results. *Otsuka Pharm. Co., Ltd. v. Torrent Pharms. Co., Ltd.,* 151 F. Supp. 3d 525, 548–49 (D.N.J. 2015); *Jobdiva, Inc. v. Monster Worldwide, Inc.*, No. 13-cv-8229 (KBF), 2014 WL 5034674, at *18–19 (S.D.N.Y. Oct. 3, 2014); *Butamax Advanced Biofuels LLC v. Gevo, Inc.*, 117 F. Supp. 3d 632, 641 (D. Del. 2015). As the Federal Circuit has explained, "[b]efore *Nautilus*, a claim was not indefinite if someone skilled in the art could arrive at a method and practice that method," but "[u]nder *Nautilus* this is no longer sufficient." *Dow Chem. Co. v. Nova Chems. Corp. (Canada)*, 803 F.3d 620, 634 (Fed. Cir. 2015).

2. "Repeated execution" as the test for measuring LPHDR execution units' results.

The phrase "repeated execution" supplies the test for measuring whether the LPHDR execution units' operation is sufficiently different from exact mathematical calculations to satisfy the claimed minimum percentage of inaccuracy. For example, independent claim 1 of the '273 patent states that for at least 5% of all possible valid inputs to an operation, "repeated execution" of the same operation on the same input(s) must yield that outputs that, when averaged, differ by at least 0.05% from the result of an exact mathematical operation on the same input(s):

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> for at least X=5% of the possible valid inputs to the first operation, the statistical mean, over repeated execution of the first operation on each specific input from the at least X % of the possible valid inputs to the first operation, of the numerical values represented by the first output signal of the LPHDR unit executing the first operation on that input differs by at least Y=0.05% from the result of an exact mathematical calculation of the first operation on the numerical values of that same input.

’273 patent at 30:6-15. All of the asserted claims include identical “repeated execution” language, differing only with respect to the claimed percentages of X (possible valid inputs) and Y (difference between average and exact result).

3. Analog signals and “noise”

The asserted patents include analog embodiments. *See, e.g.*, ’273 patent at 11:32-39, 14:16-26. Analog signals are subject to a phenomenon known as “noise”—a disturbance in an electrical signal that can cause the signal’s quality to deviate from the original/intended value. *See* Decl. of Gu-Yeon Wei (“Wei Decl.”), ¶¶ 25-27. As a result, analog systems cannot generate repeatable results when executing a given operation on a particular input. *See id.*, ¶ 28. This inability to replicate results from execution of an operation would affect embodiments that are purely analog, as well as hybrid embodiments that “represent[] values as a mixture of analog and digital forms” (referred to in this brief collectively as “analog systems”). ’273 patent at 14:53-54; Wei Decl., ¶ 28. An analog LPHDR execution unit will thus be non-deterministic—that is, when the unit executes the same operation on the same input over multiple instances, the results will be unpredictable and will often vary over those multiple instances. Wei Decl., ¶¶ 25-30.

4. The asserted patents’ indefiniteness due to failure to disclose the number of “repeated executions” required

In the context of the asserted patents, understanding how many repetitions are necessary to constitute “repeated execution” is necessary to determine whether this claim requirement is met because the patents contemplate repeating the same operation multiple times on the same input(s)

to determine whether an average result differs from an exact result by some minimum specified percentage. Wei Decl., ¶ 34. None of the claims, however, set forth a specific number of "repeated executions" to determine the percentage difference between the execution units' average results and exact results. Nor do the asserted patents' specification or prosecution history provide any guidance on how many repeated executions are required. And while "repeated" certainly means "more than one," that basic definition does not provide reasonably clear boundaries for the invention's scope because the asserted patents' inclusion of analog embodiments forecloses certainty about the number of repetitions required.

As noted, because analog systems are non-deterministic, the "repeated execution" of an operation in an analog system will generate multiple different results that can be averaged together and then measured against an exact result, as the asserted patents contemplate. *Id.*, ¶ 36. But that very non-repeatability—*i.e.*, the unpredictability of results of the same operation over multiple executions—is what requires knowing how many repetitions should be used to calculate the average to be compared against the exact value. It is the lack of any claim element much less disclosure in the specification directed to the number of required repetitions that renders the "repeated operation" limitation indefinite.

To illustrate the problem, consider the example of the operation of "2 x 1," executed repeatedly in an analog system in which actual results can differ from an exact result by up to 5% (*i.e.*, actual results can range from 1.9 to 2.1):

Execution Number	Result of Execution	% Difference Between Result of Execution and Exact Result
1	2.0300	1.5000%
2	2.0105	0.5250%
3	1.9620	(1.9000%)
4	2.0013	0.0650%
5	2.0463	2.3150%
6	1.9506	(2.4700%)
7	2.0903	4.5150%
8	1.9163	(4.1850%)
9	1.9984	(0.0800%)
10	1.9960	(0.2000%)

Id., ¶¶ 38-40. Given the different results for each individual execution of the operation, the delta between the average cumulative result and the exact result will shift. For instance:

Number of Times Operation Is Executed	Cumulative Average Result of All Executions	% Difference Between Cumulative Average Result of Execution and Exact Result
1	2.0300	1.5000%
2	2.0203	1.0125%
3	2.0008	0.0417%
4	2.0010	0.0475%
5	2.0100	0.5010%
6	2.0001	0.0058%
7	2.0130	0.6500%
8	2.0009	0.0456%
9	2.0006	0.0317%
10	2.0002	0.0085%

Id., ¶ 41.

In this illustrative scenario, executing the operation two, five, or seven times (the rows highlighted in red) yields an average result that differs from the exact result (2) by more than 0.05%, which is the minimum level of difference claimed by independent claim 1 of the '273 patent. *Id.*, ¶ 42. At the same time, executing the operation three, four, six, eight, nine, and ten times (the rows highlighted in blue) yields an average result that differs from an exact result by

less than 0.05%. *Id.* All of those average results are, literally, the product of "repeated execution" of the same operation. *Id.* But while the former set of results meets the claimed 0.05% difference from the exact result in claim 1 of the '273 patent, the latter set does not. *Id.* "Repeated execution" thus does nothing to delineate whether and when an LPHDR execution unit generates results that, on average, meet the claimed minimum levels of difference. *Id.*, ¶ 43. To the contrary, one can envision a situation in which a processor might be accused of infringement based on just two or three repetitions, even if its continued operation would not satisfy the claim language. Conversely, one can envision a processor that gradually gets more unpredictable (due to increased noise caused by heat) and therefore might be accused of infringement only after some unspecified number of repeated executions has occurred.

Nothing in the asserted patents' claim language, specification, or prosecution history purports to resolve this lack of a clear dividing line between a device that falls within the scope of the claim and a device that falls outside the scope of the claim. *Id.*, ¶¶ 44-48. That silence is unsurprising: the essence of an analog system is that average results from repeatedly executing the same operation on a particular input will be a moving target, given that noise is inevitable and cannot be fully mitigated. *Id.*, ¶ 49.

Well-settled law, however, holds that the metes and bounds of a claim are not reasonably clear when different potential testing leads to different results. *Dow Chem.*, 803 F.3d at 634; *Otsuka Pharm.,* 151 F. Supp. 3d at 548–49; *Jobdiva*, 2014 WL 5034674, at *18–19; *Butamax Advanced Biofuels.*, 117 F. Supp. 3d at 641. That is the case here: different numbers of executions of an operation are, in effect, different tests, and are bound to yield inconsistent average results. Indeed, the boundaries of "repeated execution" are even less clear because even the ***same*** test can yield different results. Because noise in an analog system is inevitable, one can readily envision a

situation in which identical numbers of repeated executions, performed at different times, yield different average results.

To be sure, the asserted patents also encompass digital embodiments, which conventionally will be deterministic—*i.e.*, involve no randomness in the calculation of an output from an input. *E.g.*, '273 patent at 10:42-45, 11:30-32, 11:53-58, 12:50-67; Wei Decl., ¶¶ 18-20, 22. So, while a digital system performing the operation "2 x 1," might, like an analog system, yield an inexact result—such as 2.1—a digital system typically will, unlike an analog system, yield the ***same*** result every time it executes the operation. Wei Decl., ¶¶ 23-25. Thus, performing "repeated executions" of an operation does little or nothing to help measure a digital LPHDR execution unit's lack of precision; the claim language is only meaningful as applied to analog and non-deterministic digital embodiments, which cannot generate repeatable results through execution of the same operation.

In summary, the phrase "repeated execution" is relevant to the asserted patents' analog embodiments, for which the phrase's boundaries are impossible to discern because infringement rests on the unknown and unclaimed number of times an operation is repeated. That problem is the essence of indefiniteness and it taints every claim of the asserted patents. The Court should therefore hold the asserted patents indefinite.

B. In the event the Court does not find the asserted patents indefinite, it should adopt Google's proposed claim constructions.

1. Legal standard

Claim construction is a matter of law. *Markman v. Westview Instruments, Inc.*, 517 U.S. 370, 387 (1996). "The appropriate starting point [] is always with the language of the asserted claim itself." *Comark Commc'ns, Inc. v. Harris Corp.*, 156 F.3d 1182, 1186 (Fed. Cir. 1998). That language should be read first and foremost in light of the specification, which is "the single best guide to the meaning of a disputed term." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir.

2005) (*en banc*). As a general matter, the correct claim construction is the one that "stays true to the claim language and most naturally aligns with the patent's description of the invention." *Id*. at 1316. (quoting *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1250 (Fed. Cir. 1998)). Accordingly, "the interpretation to be given a [claim] term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to envelop with the claim." *Id.* (same). The claim language, written description, and patent prosecution history thus form the intrinsic record that is most significant when determining the proper meaning of a disputed claim limitation. *Id.* at 1315-17; *see also Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996).

The Court may also consider extrinsic evidence such as expert and inventor testimony, dictionaries, and learned treatises, "if the court deems it helpful in determining 'the true meaning of language used in the patent claims.'" *Phillips,* 415 F.3d at 1318 (quoting *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 980 (Fed. Cir. 1995)). But extrinsic evidence may not be used to contradict or change the meaning of claims, "thereby undermining the public notice function of patents." *Id.* at 1319 (quoting *Southwall Techs., Inc. v. Cardinal IG Co.*, 54 F.3d 1570, 1578 (Fed. Cir. 1995)).

The Court's ultimate goal in construing claim terms is "giv[ing] the jury guidance that 'can be understood and given effect by the jury once it resolves the issues of fact which are in dispute.'" *Sulzer Textil A.G. v. Picanol N.V.*, 358 F.3d 1356, 1366 (Fed. Cir. 2004) (quoting *Structural Rubber Prods. Co. v. Park Rubber Co.*, 749 F.2d 707, 718 (Fed. Cir. 1984)). The jury must be able to "intelligently determine the questions presented." *Id.* (citation and internal quotation marks omitted). Thus, the "plain and ordinary meaning" of technical terms is only helpful when that meaning is "readily apparent even to lay [people]." *Phillips*, 415 F.3d at 1314.

2. "low precision high dynamic range execution unit"

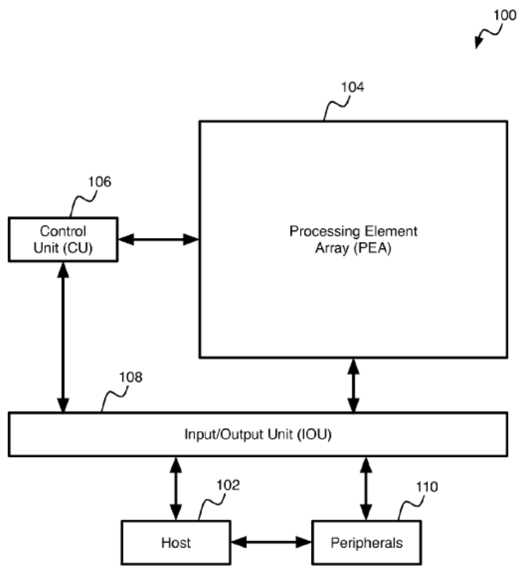
"LPHDR execution unit"		
Claims	**Google's Proposed Construction**	**Singular's Proposed Construction**
All claims	"low precision and high dynamic range processing element designed to perform arithmetic operations on numerical values"	"processing element comprising an arithmetic circuit paired with a memory circuit"

The term "low precision high dynamic range execution unit" ("LPHDR execution unit") appears in every asserted claim in the three patents-in-suit. The parties agree that some or all of this term warrants construction. What's more, the parties' respective interpretations share striking similarities. The lone substantive difference is Singular's contention that an "execution unit" is necessarily paired with a memory circuit. But only Google's proposed interpretation stays true to the claim language in light of the specification.

Google proposes that the proper meaning of this term is "low precision and high dynamic range processing element designed to perform arithmetic operations on numerical values." Singular apparently agrees with most of this interpretation. Its competing construction shares Google's understanding that an "execution unit" is a processing element that performs arithmetic on numerical values. This common ground is not surprising. As the patents repeatedly make clear, the term "execution unit" is properly construed as a "processing element."[4] The earliest patent, the '273 patent, is even titled "Processing with Compact Arithmetic *Processing Element*." (Emphasis added.) Unlike the patents' specifications and abstracts, the claims do not use the phrase "processing element." But the intrinsic record makes clear that the two terms—"execution unit" and "processing element"—are synonymous. In fact, the specification makes this definition

[4] The parties apparently agree on this much: Singular's proposed construction of "execution unit," discussed in detail below, similarly equates the term with a "processing element."

explicit: "references herein to 'processing elements' within embodiments of the present invention should be understood more generally as any kind of execution unit." '273 patent at 8:7-11. The patents go on to claim a device that contains "a digital processor adapted to control the operation of the at least one first LPHDR execution unit." *See, e.g.*, '273 patent, claim 24. As Figure 1 of the '273 patent makes clear, this control unit operates on the invention's processing element, *i.e.*, the LPDHR execution unit:



'273 patent, Fig. 1.

Similarly, there should be no doubt that these processing elements perform arithmetic operations on numerical values. Claim 1 of each patent identifies a "device comprising: at least one first low precision high dynamic range (LPHDR) execution unit adapted to execute a first operation on a first input signal representing a first numerical value to produce a first output signal representing a second numerical value . . . ." *See, e.g.*, '273 patent at 29:65-30:3. Other intrinsic evidence supports Google's interpretation. For example, in the very first sentence of the abstract to the '273 patent, Dr. Bates describes his invention as a device including "processing elements

designed to perform arithmetic operations . . . on numerical values . . . ." '273 patent, Abstract. This definition is repeated later in the Summary of the patent. *Id.* at 2:11-18.

The only substantive point of contention is Singular's assertion that the "execution unit" *must* also include a "memory circuit." But the intrinsic record here provides stronger support for Google's proposed construction. Just as importantly, Google's proposed construction would provide clearer guidance to a jury tasked with interpreting the term.

To begin, none of the three patents contains the phrase "memory circuit," let alone in the context of the LPHDR execution unit. In fact, none of Singular's asserted claims—or the claims on which they depend—refer to memory. Although other claims refer to memory, these references undercut Singular's construction, because the claims make clear that LPHDR execution units do not *necessarily* contain memory. For instance, dependent claim 25 of the '273 patent, which is not asserted here, introduces the following limitation: "The device of claim 1 . . . wherein the device includes memory locally accessible to at least one of the LPHDR execution units . . . ." Under Singular's construction of "execution unit," however, the memory limitation in claim 25 would be rendered redundant. Such constructions are disfavored. *See Phillips,* 415 F.3d at 1324-25 (explaining that redundant claim construction should be avoided); *see also Liebel-Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 910 (Fed. Cir. 2004) ("The juxtaposition of independent claims lacking any reference to a [specific limitation] with dependent claims that add a [specific] limitation provides strong support for [plaintiff's] argument that the independent claims were not intended to require the presence of a pressure jacket."); *SunRace Roots Enter. Co. v. SRAM Corp.,* 336 F.3d 1298, 1302–03 (Fed. Cir. 2003) (holding that the presumption that an independent claim does not have a limitation that is introduced for the first time in a dependent claim "is especially strong when the limitation in dispute is the only meaningful difference between an

independent and dependent claim, and one party is urging that the limitation in the dependent claim should be read into the independent claim").

By the same token, the specification indicates that certain embodiments implement the invention in software, not just hardware. *See e.g.*, '273 patent at 25:41-44 ("certain embodiments of the present invention are described herein as executing software"). Singular's proposed construction is therefore impossible to square with the specification. By defining an execution unit as containing a "memory circuit," Singular improperly tries to introduce a hardware limitation into patent claims that contemplate a software embodiment.

The remaining discrepancy between the parties' constructions is less consequential. While Google defines an LPHDR execution unit as a "processing element designed to perform arithmetic operations on numerical values," Singular uses the term "arithmetic circuit." As Google understands this aspect of Singular's construction, the parties are largely on common ground and agree that the LPHDR execution unit performs arithmetic on numerical values. But Google's interpretation offers greater continuity with and connection to other claim elements, such as the "first input signal representing a first numerical value," discussed below. That is, in contrast to Singular's proposed construction, Google's proposed constructions, taken together, clarify that the LPHDR execution unit performs arithmetic on the numerical value represented by the first input signal.

Ultimately, the Court's goal in construing claim terms is "giv[ing] the jury guidance that 'can be understood and given effect by the jury once it resolves the issues of fact which are in dispute.'" *Sulzer Textil A.G.,* 358 F.3d at 1366 (quoting *Structural Rubber Prods.,* 749 F.2d at 718. Google's phrasing does just that, explaining the term "LPHDR execution unit" in clearer language

that relates to the other asserted claims in this case. For all these reasons, the Court should adopt Google's construction of LPHDR execution unit.

3. "first input signal representing a first numerical value"

"first input signal representing a first numerical value"	
Claims	**Google's Proposed Construction**
All claims	"A digital and/or analog representation of a value that the LPHDR execution unit operates on"[5]

Google proposes that "a first input signal representing a first numerical value" be construed as "a digital and/or analog representation of a value that the LPHDR execution unit operates on." This construction clarifies the claim language in two important respects.

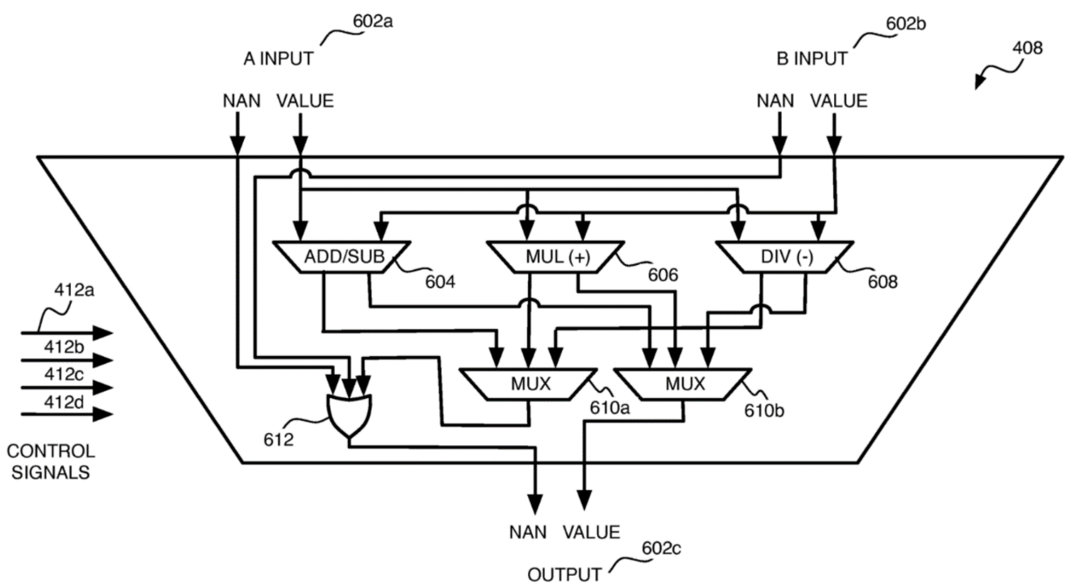
First, it specifies that the "first input signal representing a first numerical value" can be an analog signal, a digital signal, or a combination of the two. The specification confirms that this construction is correct. It describes how embodiments of the claimed invention might "operate[] on digital (binary) representations of numbers," '273 patent at 11:54; "use analog representations and processing mechanisms," *id.* at 6:23-24; or "represent[] values as a mixture of analog and digital forms," *id.* at 14:53-54 and 24:54-57. *See also id.* at 24:47-49 ("[E]mbodiment[s] of the present invention may represent values in any of a variety of ways, such as by using digital or analog representations . . . .").

Second, Google's proposed construction clarifies that the numerical value represented by the "first input signal" is the numerical value on which the LPHDR execution unit operates. This,

[5] Google notes that its proposed construction here differs slightly from its initial proposal in form but not substance. The construction Google offered as part of its Proposed Claim Terms for Construction on December 4, 2020 used the phrase "processing element" instead of "execution unit." For the reasons discussed above with regard to the term "LPHDR execution unit," this is a distinction without a difference. Google has revised its construction in order to avoid an unnecessary disparity between the terms it has proposed for construction.

too, is detailed in the specification, which states that "[t]he input . . . 'values' . . . operated on by the [LPHDR execution unit] may, for example, take the form of electrical signals representing numerical values." '273 patent at 10:64-67. In addition, Figure 6 depicts "an example digital implementation of the LPHDR arithmetic unit" (a component of the LPHDR execution unit) that illustrates the numerical values represented by the "first input signal" as the values that the LPHDR unit uses to perform computations.

Fig. 6



As shown in Figure 6, the arithmetic unit in the LPHDR execution unit "receives two inputs" (**602**a and **602**b), which "may . . . take the form of electrical signals representing numerical values." '273 patent at 12:52-55. And "all the available arithmetic operations are performed in parallel on the inputs **602** *a-b* by adder/subtractor **604**, multiplier **606**, and divider **608**." *Id.* at 12:62-65.

Notably, Google's construction avoids a potential indefiniteness problem with this term. Specifically, adopting a construction that expressly confirms that the LPHDR execution unit operates on the numerical value represented by the "first input signal" has the virtue of identifying the antecedent basis for the claim language's later reference to "***the*** possible valid inputs" to the operation performed by the LPHDR execution unit. *Id.* at 30:4 (emphasis added). "[W]here . . . a

claim term first appears with the indefinite article 'a' and later appears with a definite article, such as 'the,' the Federal Circuit has found that the terms share an 'antecedent basis' relationship and apply an 'initial assumption' that the latter occurrence carries the same meaning as the former." *X One, Inc. v. Uber Techs., Inc.*, 440 F. Supp. 3d 1019, 1034–35 (2020) (citing *Microprocessor Enhancement Corp. v. Tex. Instruments Inc.*, 520 F.3d 1367, 1375 (Fed. Cir. 2008)).

Without Google's proposed construction, the asserted patents' claim language might "fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention," *Nautilus*, 572 U.S. at 901. The antecedent basis for "***the*** possible valid inputs" must be "***a*** numerical value" represented by the "first input signal." Otherwise, "the possible valid inputs" refers to the "first input signal" itself: "wherein the dynamic range of the possible valid inputs to the first operation is at least as wide as from 1/65,000 [or 1/1,000,000] through 65,000 [or 1,000,000]. But the "first input signal" does not itself have a dynamic range; rather, the possible numerical values represented by the "first input signal" have the claimed dynamic range. Accordingly, to avoid an antecedent basis issue, the Court should construe the claim language to clarify that the operations are performed on the numerical value represented by the input signal, rather than on the signal itself. Courts regularly adopt constructions to avoid precisely this kind of ambiguity. *See Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1356–57 (Fed. Cir. 1999) (adopting construction to "avoid[] any lack of antecedent basis problem"); *see also Haemonetics Corp. v. Baxter Healthcare Corp.*, 607 F.3d 776, 781–82 (Fed. Cir. 2010) (rejecting a claim construction that "ignores the antecedent basis" of the disputed claim term and thus "fails to give effect to the claim language"). *Id.* at 782. Indeed, absent construction, it would be unclear what the "possible valid inputs" to the LPHDR execution unit's operations could be, what form they take, or where they come from—the term could refer to any number of numerical values

which may (or may not) have a direct relation to the operations performed by the LPHDR execution units.

IV. CONCLUSION

For the foregoing reasons, Google respectfully requests that the Court find that the term "repeated execution" and, by extension, the asserted patents, are indefinite. In the alternative, Google respectfully requests that the Court adopt Google's proposed constructions for "low precision high dynamic range execution unit" and "first input signal representing a first numerical value."

Respectfully submitted,

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CERTIFICATE OF SERVICE

I certify that this document is being filed through the Court's electronic filing system, which serves counsel for other parties who are registered participants as identified on the Notice of Electronic Filing (NEF). Any counsel for other parties who are not registered participants are being served by first class mail on the date of electronic filing.

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